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(54) Treatment of aqueous waste material.

(57) A volume of aqueous waste material containing organic solids is passed to a pressure vessel 10 and has a volume of ozonised oxygen introduced therein to create a superatmospheric pressure in the head space 14. A stream is continuously withdrawn from the vessel 10 by pump 18 which is effective to comminute solids. Ozonised oxygen is drawn from headspace 14 via conduit 24 into the stream to form a dispersion of bubbles therein. The bubbles are carried with the stream to a nozzle 28 from which they are reintroduced into the liquid in the vessel 10 with the creation of turbulence to facilitate their dissolution. Treated liquid may be discharged to a flotation tank to separate particulate solids therefrom. The resulting solids may then be dewatered.

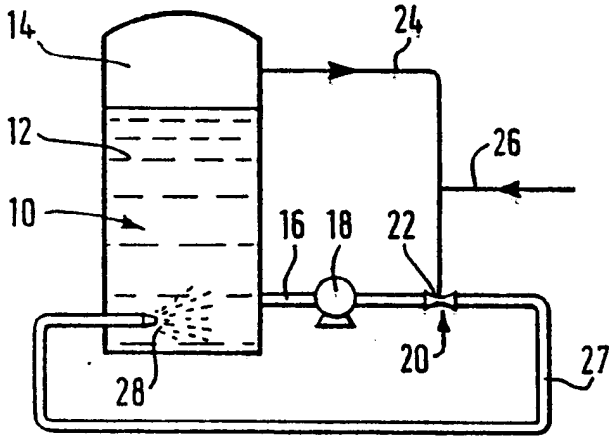

FIG. 2.

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Treatment of Aqueous Waste Material

This invention to the treatment of aqueous waste material. It is paticularly concerned with the treatment of sewage sludge and animal slurry.

Sewage sludge and animal slurry are typically characterised by having a relatively high biochemical oxygen demand. Thus, traditional aerobic or anaerobic treatments of such aqueous waste materials are particularly time consuming, and accordingly, in the event that such treatments are employed, there is a need for substantial holding tanks and the like to be provided upstream of the main treatment vessel or vessels. Frequently, the land necessary for such holding vessels is not available.

We believe substantial improvements in the treatment of sewage sludge and animal slurry may be achieved by the effective utilisation of ozonised oxygen as a treatment gas.

According to the present invention there is provided a method of treating aqueous waste material containing organic solids, comprising establishing in a pressure vessel a volume of the aqueous waste material to be treated, comminuting solids in the waste material externally of the pressure vessel, continuously withdrawing a stream of aqueous material from the pressure vessel, introducing ozonised oxygen into the stream, forming a dispersion of the bubbles of ozonised oxygen in the stream, re-introducing the stream into the volume of waste material in the vessel, creating turbulence at the region of introduction, collecting indissolved ozonised oxygen in the head space of the vessel, and withdrawing gas from the head space and introducing it into said stream to form said bubbles.

The invention also provides apparatus for treating aqueous waste material containing organic solids, comprising a pressure vessel having an inlet for the aqueous waste material, and an outlet for withdrawing a stream of aqueous waste material therefrom; means exterior to the pressure vessel for comminuting solids in the organic waste material; means for withdrawing a stream of aqueous material from the vessel; means for introducing ozonised oxygen into said stream such that a dispersion of bubbles of ozonised oxygen in the stream is able to be formed; means for reintroducing the stream into the waste material in the vessel; means for creating turbulence at the region of reintroduction, and wherein said means for introducing ozonised oxygen into said stream comprises means for withdrawing ozonised oxygen from the head space of the vessel, and for passing it into said stream.

Utilisation of ozonised oxygen facilitates relatively rapid reduction in the biochemical oxygen demand of the waste material. In particular ozonised oxygen helps to render the material sterile, and facilitates a breakdown of organic compounds that are relatively difficult to oxidise (for example phenols). It is believed that the rate determining step in the treatment is the dissolution of the ozonised oxygen. By contacting bubbles of the ozonised oxygen with a stream of the waste material, relatively rapid dissolution of the ozone and oxygen is facilitated. Moreover, it is not necessary to rely upon transfer of gas from the ullage or head space of the pressure vessel to a liquid surface exposed to the ullage space in order to effect transfer of the oxygen and the ozone to the liquid phase. It is accordingly, possible to operate the pressure vessel with a relatively small ullage space.

The method according to the invention is typically operated as a batch treatment in which, on average, during the residence of the aqueous waste material in the vessel it is recycled 5 to 50 times. If desired, however, the process can be operated continuously, typically with there being a plurality of pressure vessels arranged in sequence, with continuous flow of the liquid of a treatment into the most upstream vessel and continuous flow of liquid from one vessel to the next in sequence, and continuous withdrawal of treated liquid from the most downstream of the vessels, each pressure vessel having associated therewith its own means for withdrawing and recirculating aqueous waste material, each such means having means for introducing ozonised oxygen into the recirculating liquid.

Preferably, the pH of the aqueous waste material is adjusted prior to its introduction into the pressure vessel. Thus, sewage sludge is typically digested for the relatively short period, say in the order of 0.5 to 1 hour in sulphuric acid at a pH of about three, such digestion facilitating the breakdown of fibrous material. Typically, this treatment is performed in a holding tank upstream of the or each pressure vessel. A communicating pump recycling the waste material to and from the holding tank may be used to assist in the breakdown of fibrous material in the sludge or other aqueous waste material.

In a batch method according to the invention, the desired reduction in the biochemical oxygen demand of the aqueous waste material may typically be effected in a matter or hours rather than in the days that are required by prior art methods that rely on aerobic or anaerobic digestion of sludge.

Upon completing the treatment to reduce the biochemical oxygen demand of the volume of aqueous material, this volume is preferably then released from the vessel to a flotation tank which is typically open to the atmosphere. Accordingly, gas bubbles are released from the volume of liquid in the flotation tank, thereby causing particles to float to the surface. Such particulate material is then extracted from the flotation tank and passed through a belt press in order to de-water it. This material is relatively easily pressed and is found to be suitable for use for direct land fill.

A method and apparatus according the invention are now described by way of example with reference to the accompanying drawings, in which:

Figure 1 is a block diagram illustrating a process for treating sewage sludge or animal slurries or other forms of aqueous waste material having a relatively high biochemical oxygen demand, and

Figure 2 illustrates apparatus according to the invention for the oxygenation and ozonisation of aqueous waste material as part of the process illustrated in Figure 1.

Referring to Figure 1 of the drawings, incomming aqueous waste material for treatment, containing suspended organic solids, and typically having a biochemical oxygen demand in the range 1000 to 10,000 parts per million, flows into a holding tank 2, and sulphuric acid added to it until its pH reaches the value of 3. The aqueous waste material is allowed to stand for, say, half an hour. It is then passed into an aparatus 4 for the oxygenation and ozonisation of the waste material. After about 2 hours treatment with oxygen and ozone, the treated liquid then passed to a flotation tank at atomospheric pressure. Dissolved oxygen comes out of solution and floats particles to the top of the surface in the tank 6. Particles floating on the surface and then removed therefrom and dewatered in a press 8 to form a waste containing about 40% solids which can for example be used for land fill purposes. Water from the tank 6 and the press 8 may be discharged directly to the environment.

An example of the apparatus 4 is shown in Figure 2 of the accompanying drawings. Referring to Figure 2, the illustrated apparatus also includes an upright cylindrical pressure vessel 10 holding a volume 12 of the aqueous waste material under the pressure of gas of about 5 atmospheres absolute in an ullage or head space 14 at the top of the vessel 10. Liquid is withdrawn from the vessel 10 from an outlet 16 near its base by means of a sewage pump 18 having a rotor (not shown) provided with comminution means (not shown) adapted to shred solid materials. (The pump may also have an additional inlet able to be placed in communication with the holding tank 2 (See Figure 1) to enable the vessel 10 to be intially charged with the aqueous waste material. Ozonised oxygen is then introduced therein by one of the means described below to create in the head space 14 a gaseous atmosphere comprising ozonised oxygen at superatmospheric pressure. The outlet of the pump 18 communicates with a venturi 20 which has a throat 22 at a lower pressure than the pressure in the head space 14 of the vessel 10 and communicating with the head space 14 by way of a conduit 24. In operation, ozonised oxygen is thus drawn from the head space 14 into liquid flowing through the venturi 20. The pressure in the head space or ullage space 14 is preferably kept between chosen limits by appropriate addition of make-up oxygen-ozone from a source thereof which may comprise any commercially available ozoniser. Make-up ozonised oxygen is typically added to the conduit 24 through an inlet 26. Alternatively, it may be added directly to the head space of the pressure vessel 10 or may added to the stream of liquid produced by the pump 18 through a separate venturi (not shown).

The venturi 20 is effective to create turbulence in the flow of liquid at its throat and thus the ozonised oxygen enters a turbulent flow of liquid. The turbulence helps to break the ozonised oxygen gas into bubbles, some of which dissolve in the aqueous waste material. The undissolved gas is conducted in the form of bubbles along a conduit 27 which terminates in a nozzle 28 within the volume 12 of aqueous waste material. In operation, the pump 18, the venturi 20 and conduit 27 are so arranged as to maintain the bubbles in dispersion throughout their travel along the conduit 27 without there being any significant coalescence of gas bubbles to form discrete slugs of gas and such that the liquid-gas mixture issues from the nozzle 28 turbulently, whereby the turbulence is able to shear the bubbles into even finer bubbles which may readily dissolve in the liquid in the vessel 10. Some bubbles will however pass into the ullage space 14, or gas will come out of solution and pass into the ullage space 14. The oxygen is employed to add the respiration aerobic micro-organisms which are naturally contained in the aqueous waste material and which break down or oxidise organic pollutants in the material. The presence of ozone considerably facilitates the oxidation of certain organic species such as phenols. It is believed that the rate determining step in effecting reduction of the biochemical oxygen demand of the aqueous waste material is the transfer of oxygen and ozone from the gaseous phase into solution. By forming the oxygen and ozone into bubbles and allowing for contact between the bubbles and the liquid both in the conduit 27 and in the volume 12 of the aqueous liquid, relatively rapid oxygenation takes place in comparison with conventional processes.

The rate of withdrawal of aqueous waste material through the outlet 14 may be selected in accordance with the desired reduction in the biochemical oxygen demand of the aqueous waste material.

After treatment of the oxygen and ozone for a chosen period of time, the pump 18 may be employed to tansfer the liquid to the fermentation tank 6 shown in Figure 1. Gas comming out of solution during the transfer helps to float solid particles to the surface of the liquid in the tank 6, as aforementioned.

Claims

1. A method of treating aqueous waste material containing organic solids, comprising establishing in a pressure vessel a volume of the aqueous waste material to be treated, comminuting solids in the waste material externally of the pressure vessel, continuously withdrawing a stream of aqueous material from the pressure vessel, introducing ozonised oxygen into the stream, forming a dispersion of bubbles of ozonised oxygen in the stream, re-introducing the stream into the volume of waste material in the vessel, creating turbulence at the region of introduction, collecting undissolved ozonised oxygen in the head space of the vessel, and withdrawing gas from the head space and introducing it into said stream to form said bubbles.

2. A method as claimed in claim 1, in which the pH of the aqueous waste material is adjusted prior to its introduction into the said pressure vessel by digestion in sulphuric acid.

3. A method as claimed in claim 2, in which the pH adjustment is performed in a holding tank upstream of the said pressure vessel.

4. A method as claimed in claim 3, in which a comminuting pump recycling the waste material to and from the holding tank is used to assist in break down of fibrous material in the aqueous waste material.

5. A method as claimed in any one of the preceding claims, in which aqueous waste material is released from the pressure vessel to a flotation tank open to the atmosphere.

6. A method as claimed in claim 5, in which particularte material at the surface of the liquid in the flotation tank is separated therefrom, and is passed through a belt-press to dewater it.

7. A method as claimed in any one of claims 1 to 6, in which, on average, during the residence of the aqueous waste material in the pressure vessel it is recycled from 5 to 50 times.

8. A method as claimed in claim 1 or claim 2, in which there is a plurality of pressure vessels, arranged in sequence, with there being a continuous flow of aqueous waste material from one vessel in the sequence to the next and continuous withdrawal of treated liquid from the most downstream of the vessels, aqueous waste material being recirculated to and from each vessel and ozonised oxygen being introduced into each recirculating liquid.

9. Apparatus for treating aqueous waste material containing organic solids, comprising a pressure vessel having an inlet for the aqueous waste material, and an outlet for withdrawing a stream of aqueous waste material therefrom; means exterior to the pressure vessel for comminuting solids in the organic waste material; means for withdrawing a stream of aqueous material from the vessel; means for introducing ozonised oxygen into said stream such that a dispersion of bubbles of ozonised oxygen in the stream is able to be formed; means for reintroducing the stream into the waste material in the vessel; and means for creating turbulence at the region of reintroduction, wherein said means for introducing oxygen into said stream comprises means for withdrawing ozonised oxygen from the head space of the vessel, and for passing it into said stream.

10. Apparatus as claimed in claim 9, additionally including a holding tank upstream of the said pressure vessel whereby the pH of said aqueous waste material may be adjusted in said tank.

11. Apparatus as claimed in claim 10, additionally including a pump for recycling the waste material to and from the holding tank.

12. Apparatus as claimed in any one of claims 9 to 11, additionally including a flotation tank, open to the atmosphere, downstream of the pressure vessel.

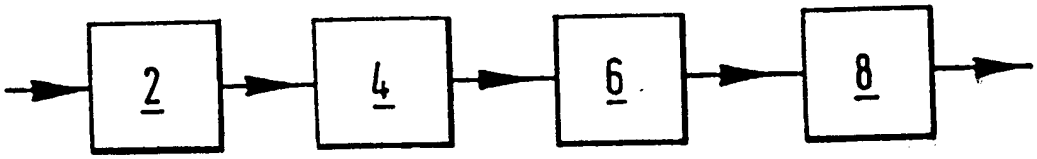

FIG.1.

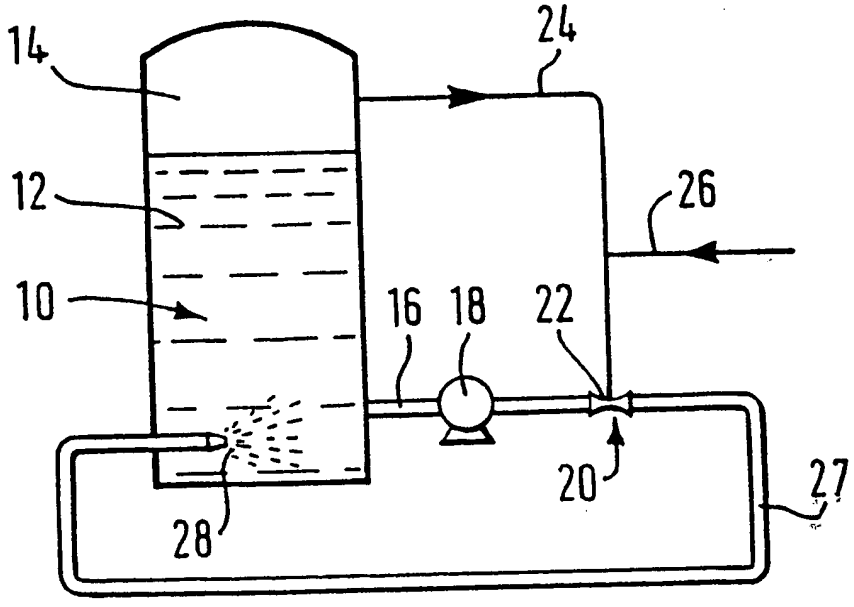

FIG.2.

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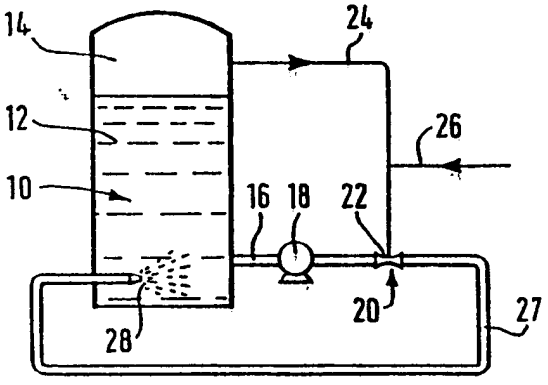

FIG. 2.

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EUROPEAN SEARCH REPORT

Application Number

EP 87 30 7762

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	GB-A-2 128 980 (PROCESS RESEARCH DEVELOPMENT) * Abstract; claims 1,5,10,16; page 1, lines 83-84; page 2, lines 33-40 *	1,2,6-9	C 02 F 11/06 C 02 F 9/00 C 02 F 1/78 C 02 F 1/24
A	US-A-3 804 755 (CERVANTES) * Claims 1,2; column 3, lines 4-10 *	1,6,9	
A	GB-A-2 073 727 (OZODYNE) * Claim 1; page 1, line 127 - page 2, line 5; page 3, lines 16-19,126-127; page 5, lines 36-43 *	1,3,9	
A	US-A-3 772 188 (EDWARDS) * Claims 1,9,10 *	1,9	
A	GB-A-2 034 684 (GALASSI) * Claims 1,4,12,21 *	1,9	
A	CHEMICAL ABSTRACTS, vol. 95, 14th December 1981, page 334, abstract no. 209076k, Columbus, Ohio, US; & JP-A-81 91 898 (NISHIHARA ENVIRONMENTAL SANITATION RESEARCH CORP. LTD.) 25-07-1981	5	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

C 02 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	09-05-1988	KASPERS H.M.C.

CATEGORY OF CITED DOCUMENTS

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